Ontario

GUIDELINE

LEAD ON CONSTRUCTION PROJECTS

Health and Safety Guidelines

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LEAD ON CONSTRUCTION PROJECTS

Occupational Health and Safety Branch
Ministry of Labour

April 2011

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Foreword

This Guideline has been prepared to assist persons, such as employers, construction project owners, constructors, contractors and subcontractors, who have duties under the Occupational Health and Safety (OHSA) and its regulations to protect workers from exposure to lead. It should not be taken to be a statement of the law or what is necessary to comply with the law. A person with legal duties may or may not agree with the Guideline and there is no legal requirement to follow the Guideline. It is for each such person to decide what is necessary to comply with the OHSA and its regulations.

A person who needs assistance in determining what constitutes compliance should consult with his or her legal advisor. Ministry inspectors will assess workplace situations against the relevant provisions of the OHSA and its regulations but they do not enforce the Guideline, although they may refer to it in determining whether the relevant laws have been complied with.

1.0 INTRODUCTION

Scope

Employers have a duty to protect their workers from lead exposure on construction projects. This guideline has been prepared to raise the awareness of employers and workers in the construction industry of the hazards posed by lead in construction and the measures and procedures that should be taken to control those hazards.

For the purpose of this guideline, lead refers to inorganic lead.

Lead in Construction

Lead is a heavy metal that has been in industrial use for thousands of years. It is pale silvery grey when freshly cut but it darkens on exposure to air. It is heavy, malleable, and a poor conductor of electricity. Lead may be used in its pure elemental form or combined chemically with other elements to form lead compounds. Inorganic lead compounds are used in pigments, paints, glasses, plastics and rubber compounds.

Lead can be present on construction projects in two distinct ways:

- It can be found in construction materials, such as paints, coatings, mortar, concrete, solder, and sheet metal.
- It can be present at a construction site in existing structures, building components, and where lead was previously used in a manufacturing process.

Construction activities of particular concern include:

- abrasive blasting of structures coated with lead-based paints
- application or removal of lead-containing paints
- welding, burning, or high temperature cutting of lead-containing coatings or materials
- removal of lead-containing dust using an air mist extraction system
- removal of lead-containing mortars using an electric or pneumatic cutting device.

2.0 LEGAL REQUIREMENTS

Occupational Health and Safety Act (the OHSA)

The OHSA sets out, in very general terms, the duties of employers and others to protect workers from health and safety hazards on the job. These duties include:

- taking all reasonable precautions to protect the health and safety of workers [clause 25(2)(h)]
- ensuring that equipment, materials and protective equipment are maintained in good condition [clause 25(1)(b)]
- providing information, instruction and supervision to protect worker health and safety [clause 25(2)(a)]
- acquainting a worker or a person in authority over a worker with any hazard in the work and in the handling, storage, use, disposal and transport of any article, device, equipment or a biological, chemical or physical agent [clause 25(2)(d)].

In addition, section 30 of the OHSA deals with the presence of designated substances on construction projects. Since lead is a designated substance (O. Reg. 490/09), compliance with the OHSA and its Regulations will require some action to be taken where there is a lead hazard on a construction project.

Section 30 requires the owner of a project to determine if lead is present on a project and, if it is, to so inform all potential contractors as part of the bidding process. In a similar way, contractors who receive this information are to pass it onto other contractors and subcontractors who are bidding for work on the project. If the owner or any contractor fails to comply with this requirement, they will be liable for any loss or damages that result from a contractor subsequently discovering that lead is present.

Workplace Hazardous Materials Information System (WHMIS) Regulation, R.R.O. 1990, Reg. 860

The WHMIS Regulation applies to all workplaces covered by the OHSA. Any employer or constructor who uses WHMIS controlled products is required to comply with the WHMIS Regulation (Reg. 860) regarding the requirements for labels, material safety data sheets, and worker education and training.

The Ministry of Labour is responsible for the administration and enforcement of both federal and provincial WHMIS legislation.

Regulation for Construction Projects. O. Reg. 213/91

The Regulation for Construction Projects, O. Reg. 213/91, applies to all construction projects. Although lead is not mentioned specifically, the following sections of the O. Reg. 213/91 would apply to situations where there is the potential for workers to be exposed to lead:

Clause 14 (5) A competent person shall perform tests and observations necessary for the detection of hazardous conditions on a project.

Section 21 (1) A worker shall wear such protective clothing and use such personal protective equipment or devices as are necessary to protect the worker against the hazards to which the worker may be exposed.

(2) A worker's employer shall require the worker to comply with subsection (1).

(3) A worker required to wear personal protective clothing or use personal protective equipment or devices shall be adequately instructed and trained in the care and use of the clothing, equipment or device before wearing or using it.

Section 30 Workers who handle or use…substances likely to endanger their health shall be provided with washing facilities with clean water, soap and individual towels.

Section 46 (1) A project shall be adequately ventilated by natural or mechanical means,

(a) if a worker may be injured by inhaling a noxious…dust or fume;

(2) If it is not practicable to provide natural or mechanical ventilation in the circumstances described in clause (1)(a), respiratory protective equipment suitable for the hazard shall be provided and be used by the workers.

Section 59 If the dissemination of dust is a hazard to a worker, the dust shall be adequately controlled or each worker who may be exposed to the hazard shall be provided with adequate personal protective equipment.

Regulation for Designated Substances, O. Reg. 490/09

The Ministry's Designated Substance Regulation, O. Reg. 490/09, specifies occupational exposure limits (OELs) for 11 designated substances including lead, and requires assessment and a control program to ensure compliance with these OELs. The OEL for inorganic lead is 0.05 milligrams per cubic metre (mg/m^3) of air as an 8-hour daily or 40-hour weekly time-weighted average limit.

Although O. Reg. 490/09 and the OEL for lead do not apply to an employer on a construction project or to their workers at the project, employers still have a responsibility to protect the health of their workers and to comply with the OHSA and other applicable regulations. Section 25(2)(h) of the OHSA requires that employers take "every precaution reasonable in the circumstances for the protection of a worker".

3.0 HEALTH EFFECTS

How lead enters the body – what are the routes of entry?

Two routes of entry are of major concern: inhalation and ingestion. Airborne lead particles in the form of fumes, dusts and mists can be inhaled deeply into the lungs if they are small enough, less than five micrometres (μm), i.e., five one-millionths of a meter. Larger particles are trapped in the upper respiratory tract, cleared from the lungs, and subsequently swallowed. You can also swallow lead dust if it gets in your food or drinks, or if you eat or smoke without washing your hands first.

What happens when lead enters the body – what are the health effects?

Shortly after lead is inhaled or ingested, it can enter the bloodstream and travel to soft tissues (such as the liver, kidneys, lungs, brain, spleen, muscles, and heart). After several weeks, most of the lead moves into your bones and teeth and can be stored there for a long time. Therefore, exposure to small amounts of lead can build up over time, and the more lead you have in your body, the more likely it is that you will experience health problems.

Early signs of lead poisoning include:

- tiredness
- irritability
- muscle and joint pain
- headaches
- stomach aches and cramps.

Harmful effects can follow a high exposure over a short period of time **(acute poisoning)**, or long-term exposure to lower doses **(chronic poisoning)**. Symptoms of acute lead poisoning include a metallic taste in the mouth and gastrointestinal symptoms such as vomiting, abdominal cramps, constipation, and diarrhea. Symptoms of chronic lead poisoning are more difficult to recognize because they are similar to many common complaints. However, severe chronic poisoning can lead to more characteristic symptoms, such as a blue line on the gums, wrist drop (the inability to hold the hand extended), severe abdominal pain and pallor.

Lead can also cause serious damage to a number of systems in the body. Overexposure to lead can affect:

> **Blood:** Lead can interfere with the body's ability to manufacture hemoglobin, the molecule in red blood cells responsible for carrying oxygen to the tissues. This may lead to anemia.

Kidneys: Kidneys purify blood before it is distributed for use by the rest of the body. However, kidneys are not effective in filtering lead from the bloodstream. In addition, lead can damage the kidneys and reduce its ability to filter waste from the bloodstream.

Gastrointestinal System: Lead poisoning may result in abdominal pain, loss of appetite, vomiting, nausea, constipation or diarrhea.

Nervous System: Lead poisoning can cause peripheral nerve damage that results in muscle weakness. It may also lead to behavioural changes and to impairment of vision and hearing. At very high levels, lead can affect the brain, causing convulsions, coma, and even death.

Reproductive System: Lead may harm the developing fetus because of the shared blood supply between a mother and her fetus. Exposure of pregnant women to excessive lead may result in miscarriages and stillbirths. Overexposure to lead in men can impair sperm production.

Bones and Teeth: Absorbed lead can be deposited and stored in mineralizing tissues (bones and teeth) for a long period of time. Under certain circumstances, the release of stored lead increases and can re-enter the blood and target other systems in the body. The release of stored lead increases during periods of pregnancy, lactation, menopause, physiologic stress, chronic disease, hyperthyroidism, kidney disease, broken bones, and advanced age, and is exacerbated by calcium deficiency.

Although there are many possible symptoms, they should not be relied upon to warn of a lead-exposure problem because some changes take a long time to develop and workers may not notice a change in their health. If workers carry lead-containing dust home on their clothes, footwear, skin or hair, their family can be exposed to lead too. Children in particular are more susceptible to the harmful effects of lead. Even low-level exposures may harm the intellectual development, behaviour, size and hearing of infants. The best approach in preventing lead poisoning is to ensure that proper lead-exposure controls are in place before any health problems are noted.

4.0 CONTROLLING THE LEAD HAZARD

Lead may affect the health of workers if it is in a form that may be inhaled (i.e. airborne particles) or ingested. In order for lead to be a hazard by inhalation, lead particles that are small enough to be inhaled must get into the air. There are three types of particles: dust, fume and mist. Lead dust consists of solid particles created through processes such as blasting, sanding, grinding, and electric or pneumatic cutting. Lead fumes are produced when lead or lead-contaminated materials are heated to temperatures above 500 °C, such as welding, high temperature cutting, and burning operations. The heating causes a vapour to be given off and the vapour condenses into solid fume particles. Mists are made up of liquid droplets suspended in air. The spray application of lead-based paint can generate a high concentration of lead-containing mist.

The strategy for controlling airborne lead hazard can therefore be broken down into three basic approaches:

- prevent lead from getting into the air
- remove lead present in the air
- if present in the air, prevent workers from inhaling it.

To prevent the ingestion of lead, workers should exercise good work and hygiene practices.

To avoid the ingestion, inhalation and unintentional transfer of lead from contaminated areas, it is essential to have the following control methods in place:

- engineering controls
- work practices and hygiene practices
- protective clothing and equipment
- training.

Even with appropriate measures to control lead, some workers may still be affected. For this reason, periodic medical examinations are important for determining if the control measures in place are effective and if workers are suffering from the effects of lead exposure. This is known as medical surveillance (see Appendix 1) and can be considered to be a method for early detection and prevention of lead poisoning.

4.1 Engineering Controls

Workplace parties, which include owners, constructors, contractors, supervisors and workers, involved in construction projects that may expose workers to lead should:

- Substitute lead-containing coatings and materials with lead-free coatings and materials (e.g. substitute lead-containing paints with non-lead based paints). This may also apply to those who develop specifications.
- Select methods and equipment for the removal or installation of lead-containing coatings and materials that will reduce dust generation (e.g. wet methods, such as wet sweeping and shovelling, reduce dust generation and should be used whenever practicable). This may also apply to those who develop the specifications.
- General mechanical ventilation should be provided to remove contaminated air from the workplace, and filtered air should be provided to replace the exhausted air.
- Local mechanical ventilation should be provided to remove contaminants at the source. This is the most effective method. Power tools that can generate lead-containing dust should be equipped with effective dust collection systems.

4.2 Work Practices and Hygiene Practices

Work practices and hygiene practices are on-the-job activities that reduce the exposure potential. Lead-containing material can accumulate on the hands, clothing and hair. From there it can be disturbed, re-suspended in air and inhaled or ingested. Workers should therefore be able to wash and shower at the end of each shift. The specific washing and decontamination facilities that should be provided for the most hazardous work are described in Section 6 of this guideline. For all work involving lead exposure, there should be no smoking, eating, drinking or chewing in contaminated areas. Food and beverages should be stored in an uncontaminated area.

An effective housekeeping program requires the regular cleanup removal of lead-containing dust and debris. Surfaces should be kept clean by washing down with water or vacuuming with a vacuum equipped with a high efficiency particulate air (HEPA) filter. Containers of lead-containing waste should be kept tightly covered to prevent dust from becoming airborne. Cleaning with compressed air or dry sweeping should be avoided.

4.3 Protective Clothing and Equipment

Personal protective clothing and equipment should be provided where workers may be exposed to lead. Appropriate personal protective clothing and equipment to prevent skin contamination, include but are not limited to coveralls or full-body work clothing; gloves, hats, and footwear or disposable coverlets; and safety glasses, face shields or goggles. Respirators should be provided to prevent the inhalation of lead where engineering controls and work practices do not control the concentration of lead to below the OEL.

Protective Clothing

The purpose of protective clothing is to prevent skin exposure and the contamination of regular clothing. All clothing and equipment that has been worn in a lead-contaminated area must be

removed at the end of each shift and be decontaminated. Under no circumstances should these be taken home. When handling lead-contaminated clothing avoid shaking, as this can be a significant source of exposure to lead dust. Lead-contaminated clothing and equipment should be placed in sealed impermeable plastic bags with proper labels indicating lead contamination. Washing facilities and procedures must be suitable for handling lead contaminated laundry.

Respirators

Where engineering controls and work practices do not control the concentration of lead to below the OEL, workers should wear respirators. If respirators are used, a respirator program should be implemented. The program should be developed in consultation with the joint health and safety committee or health and safety representative, if there is one, and should include written procedures for the selection, use, care and maintenance of personal respiratory protective equipment. Workers should be instructed and trained on the care and use of personal protective equipment before using it. Some workers may have a medical condition that causes them to have difficulty breathing when wearing a respirator. If such workers have written medical proof of their condition, they should not be required to do work that requires a respirator.

Respirator selection

Where respirators are provided, they should be appropriate in the circumstances for the anticipated concentrations of airborne lead. Respirators should be selected in accordance with the U.S. National Institute for Occupational Safety and Health (NIOSH) assigned protection factors (APF).

Use, Care, and Maintenance of Respirators

The following general use, care, and maintenance procedures should be followed whenever respirators are required:

- respirators should be used and maintained in accordance with the manufacturer's specifications
- storage of respirators should be in a convenient, clean and sanitary location and in a manner that does not subject them to damage or distortion
- respirators assigned for the exclusive use of one worker, should be cleaned, disinfected and inspected after each shift on which they are used
- respirators used by more than one worker, should be cleaned, disinfected and inspected after each use
- any respirator parts that are damaged or that have deteriorated should be replaced before the respirator is used
- please refer to CSA standard Z94.4-02 for additional information of the use and care of respirators.

Ideally respirators should be assigned for the exclusive use of one worker. But before a decision is made for a respirator to be shared by more than one worker, the following factors should be considered:

- the fit of the equipment
- the health and safety risk to the worker that supplying non-exclusive use equipment would cause
- any undue economic hardship to the employer that supplying exclusive use equipment would cause.

Respirators with a tight-fitting face-piece, must be fitted to the worker in such a way that there is an effective seal between the equipment and the worker's face. Each worker must be fitted for each type of respirator to be worn.

4.4 Training

Training is an important component in preventing worker exposure to lead. Control methods, measures and procedures can only be as effective as the workers carrying them out. It is therefore essential for training to cover the following:

- WHMIS training,
- the hazards of lead, including health effects and symptom recognition,
- personal hygiene, respirator requirements, and work measures and procedures, and
- the use, cleaning and disposal of respirators and protective equipment;

Instruction and training should be provided by a competent person. This could be the employer or someone hired by the employer. A competent person is defined under the OHSA as a person who:

- is qualified because of his/her knowledge, training and experience to organize and carry out the work safely;
- is familiar with the provisions of the act and the regulations that apply to the work; and
- has knowledge of any potential health and safety hazards in the workplace.

The health and safety representative or the representative of a joint health and safety committee should be advised about when and where the training and instruction is to be carried out.

4.5 Medical Surveillance

Medical surveillance can be used as a preventive measure. By providing regular medical examinations and biological monitoring (i.e. blood-lead tests) on workers exposed to lead, subsequent adverse health effects can be detected. The examining physician can then alert the

worker, the employer and the joint health and safety committee to exposure problems in the workplace that might otherwise go unrecognized

Workers working with lead on a regular basis should have pre-placement medical examinations that include blood-lead tests, followed by periodic medical examinations. Blood-lead tests should be taken every six months, or more frequently at the discretion of a physician. Additional information of the medical surveillance program for lead exposed workers can be found in Appendix 1.

5.0 CLASSIFICATION OF WORK

A key feature of this guideline is the classification of work. It is the classification of the work that determines the appropriate respirators, measures and procedures that should be followed to protect the worker from lead exposure. In this guideline, lead-containing construction operations are classified into three groups, Type 1, Type 2, and Type 3 operations, and can be thought of as being of low, medium and high risk. Some groups, Type 2 and Type 3, are further subdivided. From Type 1 to Type 3 operations, the corresponding respirator requirements, and measures and procedures become increasingly stringent.

The classification of typical lead-containing construction tasks is based on presumed airborne concentrations obtained from the U.S. Occupational Safety and Health Administration (OSHA), the Ontario Ministry of Labour, and published research studies. The classification of Type 1, Type 2, or Type 3 operations are grouped based on the following concentrations of airborne lead:

TYPE 1 OPERATIONS	TYPE 2 OPERATIONS		TYPE 3 OPERATIONS	
	Type 2a	Type 2b	Type 3a	Type 3b
< 0.05 mg/m^3	> 0.05 to 0.50 mg/m^3	> 0.50 to 1.25 mg/m^3	> 1.25 to 2.50 mg/m^3	> 2.50 mg/m^3

TYPE 1 OPERATIONS

- Application of lead-containing coatings with a brush or roller.
- Removal of lead-containing coatings with a chemical gel or paste and fibrous laminated cloth wrap.
- Removal of lead-containing coatings or materials using a power tool that has an effective* dust collection system equipped with a HEPA filter.
- Installation or removal of lead-containing sheet metal.
- Installation or removal of lead-containing packing, babbit or similar material.
- Removal of lead-containing coatings or materials using non-powered hand tools, other than manual scraping or sanding.
- Soldering.

* Effective implies that the dust collection system should be capable of controlling airborne lead concentration levels to below 0.05 mg/m^3. Employers should follow manufacturer's recommendations and maintenance specifications for optimal function.

TYPE 2 OPERATIONS

TYPE 2a OPERATIONS

- Welding or high temperature cutting of lead-containing coatings or materials outdoors. This operation is considered a Type 2a operation only if it is short-term, not repeated, and if the material has been stripped prior to welding or high temperature cutting. Otherwise, it will be considered a Type 3a operation.
- Removal of lead-containing coatings or materials by scraping or sanding using non-powered hand tools.
- Manual demolition of lead-painted plaster walls or building components by striking a wall with a sledgehammer or similar tool.

TYPE 2b OPERATIONS

- Spray application of lead-containing coatings.

TYPE 3 OPERATIONS

TYPE 3a OPERATIONS

- Welding or high temperature cutting of lead-containing coatings or materials indoors or in a confined space.
- Burning of a surface containing lead.
- Dry removal of lead-containing mortar using an electric or pneumatic cutting device.
- Removal of lead-containing coatings or materials using power tools without an effective dust collection system equipped with a HEPA filter.
- Removal or repair of a ventilation system used for controlling lead exposure.
- Demolition or cleanup of a facility where lead-containing products were manufactured.
- An operation that may expose a worker to lead dust, fume or mist that is not a Type 1, Type 2, or Type 3b operation.

TYPE 3b OPERATIONS

- Abrasive blasting of lead-containing coatings or materials.
- Removal of lead-containing dust using an air mist extraction system.

Employers, supervisors, and workers should be able to recognize and classify lead-containing operations in order to provide appropriate respirators, measures and procedures. Respirator requirements are listed in Table 1 for Type 1, Type 2, and Type 3 operations.

TABLE 1: RESPIRATOR REQUIREMENTS

Operations	Required Respirator
Type 1 (0 - 0.05 mg/m^3)	
• Application of lead-containing coatings with a brush or roller. • Removal of lead-containing coatings with a chemical gel or paste and fibrous laminated cloth wrap. • Removal of lead-containing coatings or materials using a power tool that has an effective dust collection system equipped with a HEPA filter. • Installation or removal of lead-containing sheet metal. • Installation or removal of lead-containing packing, babbit or similar material. • Removal of lead-containing coatings or materials with a non-powered hand tool, other than manual scraping and sanding. • Soldering.	Respirators should not be necessary if the general procedures listed in Section 6.1 are followed and if the level of lead in the air is less than 0.05 mg/m^3. However, if the worker wishes to use a respirator, a half-mask particulate respirator with N-, R- or P-series filter, and 95, 99 or 100% efficiency should be provided.
Type 2a (0.05 to 0.50 mg/m^3)	**NIOSH APF = 10**
• Welding or high temperature cutting of lead-containing coatings or materials outdoors. This operation is considered a Type 2a operation only if it is short-term, not repeated, and if the material has been stripped prior to welding or high temperature cutting. Otherwise, it will be considered a Type 3a operation. • Removal of lead-containing coatings or materials by scraping or sanding using non-powered hand tools. • Manual demolition of lead-painted plaster walls or building components by striking a wall with a sledge hammer or similar tool.	Half-mask particulate respirator with N-, R-or P-series filter, and 95, 99 or 100% efficiency.
Type 2b (0.50 mg/m^3 to 1.25 mg/m^3)	**NIOSH APF = 25**
• Spray application of lead-containing coatings.	Powered air purifying respirator equipped with a hood or helmet, and any type of high efficiency filter. Supplied air respirator equipped with a hood or helmet and operated in a continuous flow mode.

Operations	Required Respirator
Type 3a (1.25 to 2.50 mg/m^3)	**NIOSH APF = 50**
• Welding or high temperature cutting of lead-containing coatings or materials indoors or in a confined space. • Burning of a surface containing lead. • Dry removal of lead-containing mortar using an electric or pneumatic cutting device • Removal of lead-containing coatings or materials using power tools without an effective dust collection system equipped with a HEPA filter. • Removal or repair of a ventilation system used for controlling lead exposure. • Demolition or cleanup of a facility where lead-containing products were manufactured. • An operation that may expose a worker to lead dust, fume or mist that is not a Type 1,Type 2 or Type 3b operation.	Full-facepiece air-purifying respirator with N-, R-or P-series filter, and 100% efficiency. Tight-fitting powered air-purifying respirator with a high efficiency filter. Full-facepiece supplied-air respirator operated in demand mode. Half-mask or full-facepiece supplied air respirator operated in continuous-flow mode.
Type 3b (more than 2.50 mg/m^3)	**NIOSH APF ≥ 1000**
• Abrasive blasting of lead-containing coatings or materials.	Type CE abrasive-blast supplied respirator operated in a positive pressure mode with a tight-fitting half-mask facepiece.
• Removal of lead-containing dust using an air mist extraction system.	Full-facepiece supplied-air respirator operated in pressure-demand or other positive-pressure mode.

* NIOSH APF = National Institute of Occupational Safety and Health Assigned Protection Factor
Note: It is recommended that compressed air used to supply air respirators should meet the breathing air purity requirement of CSA Standard Z180.1-00. Where an oil-lubricated compressor is used to supply breathing air, a continuous carbon monoxide monitor/alarm must be provided.

6.0 MEASURES AND PROCEDURES FOR WORKING WITH LEAD

Protective measures and procedures should be implemented when working with lead. Specific measures and procedures will depend on how the work is classified. This section of the guideline outlines general measures and procedures for all work with lead, followed by specific recommendations for Type 1, Type 2, and Type 3 operations.

6.1 General Measures and Procedures for Type 1, Type 2, and Type 3 Operations

The following is a list of general measures and procedures that should be followed for **all** work with lead:

- washing facilities consisting of a wash basin, water, soap and towels should be provided and workers should use these washing facilities before eating, drinking, smoking or leaving the project;
- workers should not eat, drink, chew gum or smoke in the work area;
- drop sheets should be used below all lead operations which produce or may produce dust, chips, or debris containing lead;
- dust and waste should be cleaned up and removed by vacuuming with a HEPA filter equipped vacuum;
- clean-up after each operation should be done to prevent lead contamination and exposure to lead;
- dust and waste should be cleaned up at regular intervals and placed in a container that is:
    - dust tight
    - identified as containing lead waste
    - cleaned with a damp cloth or a vacuum equipped with a HEPA filter immediately before being removed from the work area
    - removed from the workplace frequently and at regular intervals;
- the work area should be inspected daily at least once to ensure that the work area is clean; and
- compressed air or dry sweeping should not be used to clean up any lead-containing dust or waste from a work area or from clothing.

6.2 Measures and Procedures for Type 1 Operations

Respirators should not be necessary if the general procedures (above) are followed. However, any worker who requests a respirator should be provided with a half-mask particulate respirator with N-, R- or P-series filter, and 95, 99 or 100% efficiency.

6.3 Measures and Procedures for Type 2 Operations

Preparation of the Work Area

For all Type 2 operations, signs should be posted in sufficient numbers to warn of the lead hazard. There should be a sign, at least, at each entrance to the work area. The signs should display the following information in large, clearly visible letters:

1. There is a lead dust, fume or mist hazard.
2. Access to the work area is restricted to authorized persons.
3. Respirators must be worn in the work area.

Personal Protective Clothing and Equipment

Suitable protective clothing and equipment, as recommended in Section 4.3, should be worn by every worker who enters the work area.

Where lead-containing paints or coatings are being applied by spraying, all workers in the work area should wear a powered air purifying respirator equipped with a hood or helmet and a high efficiency filter, or a supplied air respirator equipped with a hood or helmet and operated in a continuous flow mode should be adequate.

For all other Type 2 operations, a half-mask particulate respirator with N-, R- or P-series filter, and 95, 99 or 100% efficiency should be adequate.

6.4 Measures and Procedures for Type 3 Operations

6.4.1 Preparation of the Work Area

Warning signs should be provided for all Type 3 operations. Signs should be posted in sufficient numbers to warn of the lead hazard, and at least at each entrance of the work area. The signs should display the following information in large, clearly visible letters:

1. There is lead dust, fume or mist hazard.
2. Access to the work area is restricted to authorized persons.
3. Respirators must be worn in the work area.

6.4.2 Barriers, Partial Enclosures and Full Enclosures

Barriers, partial enclosures, and full enclosures are used to separate the work area from the rest of the project, and in some cases, to prevent lead exposure to other workers not directly involved in the operation. Partial and full enclosures can also prevent or reduce the dispersion of lead into the surrounding work area and environment. Barriers should only be used where full and partial enclosures are not practicable.

Barriers

Ropes or barriers do not prevent the release of contaminated dust or other contaminants into the environment. However, they can be used to restrict access of workers who are not adequately protected with proper PPE, and also prevent the entry of workers not directly involved in the operation. Ropes or barriers should be placed at a distance far enough from the operation that allows the lead-containing dust to settle. If this is not achievable, warning signs should be posted at the distance where the lead-containing dust settles to warn that access is restricted to persons wearing PPE. For example, the removal of mortar and cutting operations, ropes or barriers should be located at least 10 metres away. All workers within the barrier or warning sign zone must be adequately protected.

Partial Enclosures

Partial enclosures allow some emissions to the atmosphere outside of the enclosure. Partial enclosures may consist of vertical tarps and floor tarps so long as the tarps are overlapped and securely fixed together at the seams. A partial enclosure is not a recommended containment system if significant dust is being generated.

Full Enclosures

Full enclosures are tight enclosures (with tarps that are generally impermeable and fully sealed joints and entryways). Full enclosures allow minimal or no fugitive emissions to reach the outside environment. For full enclosures, the following requirements should be met:

- the enclosure should be made of windproof materials that are impermeable to dust
- the enclosure should be supported by a secure structure
- all joints in the enclosure should be fully sealed
- entrances to the enclosure should be equipped with overlapping tarps or air locks
- the escape of abrasive and debris from the enclosure should be controlled, at air supply points, by the use of baffles, louvers, flap seals and filters
- general mechanical ventilation should be provided to remove contaminated air from the enclosure and filtered air should be provided to replace the exhausted air
- equipment venting such air should be equipped with filters adequate to control vented air to provincial environmental standards
- the air velocity within the enclosure should provide an average minimum cross-draft or down-draft past each worker during abrasive blasting operations as follows:
    - cross-draft velocity of 0.5 m/sec (100 ft/min)
    - down-draft velocity of 0.25 m/sec (50 ft/min)

Indoor Operations

- For Type 3a operations conducted indoors, barriers, partial enclosures, or full enclosures should be provided.
- For Type 3b operations (abrasive blasting, removal of lead-containing dust using an air mist extraction system) conducted indoors, full enclosures should be provided.

Outdoor Operations

- For Type 3a and 3b operations conducted outdoors, barriers, partial enclosures, or full enclosures should be provided.
- For dry abrasive blasting conducted outdoors, full enclosures should be provided.

6.4.3 Decontamination Facility

A decontamination facility should be made available for workers carrying out for the following Type 3 operations:

Type 3a Operations

- removal of lead-containing coatings and materials using power tools without an effective dust collection system equipped with a HEPA filter
- demolition or clean-up of a facility where lead-containing products were manufactured

Type 3b Operations

- abrasive blasting of lead-containing coatings or materials
- removal of lead-containing dust using an air mist extraction system

The decontamination facility should be located as close as practicable to the work area and should consist of:

- a room suitable for changing into protective clothing and for storing contaminated protective clothing and equipment
- a shower room as described below
- a room suitable for changing into street clothes and for storing clean clothing and equipment

The rooms in the decontamination facility should be arranged in sequence and constructed so as to prevent the spread of lead dust.

The shower room in the decontamination facility should be provided with the following:

- hot and cold water or water of a constant temperature that is not less than 40° Celsius or more than 50° Celsius

- individual controls inside the room to regulate water flow and, if there is hot and cold water, temperature
- clean towels.

Prior to each shift in which a decontamination facility is being used, a competent person should inspect the facility to ensure that there are no defects that would allow lead-containing dust to escape. Defects should be repaired before the facility is used. The decontamination facility should be maintained in a clean and sanitary condition.

Workers using the decontamination facility should do the following in the order shown:

- decontaminate protective clothing that will be reused on site by vacuuming with a HEPA-filter-vacuum or by damp wiping
- remove the decontaminated protective clothing
- place protective clothing that will not be reused on site in a container suitable for lead-containing dust and waste
- shower without removing the respirator
- remove and clean the respirator

6.4.4 Dust Control Measures

General and Local Mechanical Ventilation

Where the work area is enclosed, general mechanical ventilation should be provided. The air exhausted from an enclosed work area should pass through a dust collector effective for capturing the size of particulate matter being generated and for the volume and velocity of air moving through the enclosure.

Where a dust generating operation is carried out, local mechanical ventilation should be provided to remove dust at the source. Local mechanical ventilation is highly recommended for welding, burning, and high temperature cutting of lead-containing coatings and materials, and for the removal of lead-containing coatings and materials using power tools. Where local mechanical ventilation is used, the following should be met:

- Air velocity at any point in front of or at the opening of the ventilation hood should be sufficient to overcome opposing air currents and capture the contaminated air by causing it to flow into the hood.
- Air velocity at the source should be at least 0.5 m/sec (100 ft/min)
- Air discharged from the local mechanical ventilation system should pass through a HEPA filter and be routed out of the workplace in a way that will prevent the return of contaminants to the workplace.

If local ventilation is not practicable, an appropriate respirator (as listed in Table 1) should be provided. However, the decision that local ventilation is not practicable should not be made without first consulting the joint health and safety committee or health and safety representative, if any, and without considering the following:

- any undue economic hardship to the employer that providing a local ventilation system would cause
- the frequency and duration of the operation
- any potential risks to the workers by not providing a local ventilation system.

Wet Methods

Wet methods should be incorporated in the operation to reduce dust generation. Examples of wet methods include wetting surfaces, wet scraping, and wet shovelling.

Wetting should not be used if it would create a hazard or could cause damage to equipment or to the project. Power tools should be equipped with a shroud, and the shroud should be kept flush with the surface.

6.4.5 Personal Protective Equipment

Protective Clothing

Every worker who enters a Type 3 operation work area should wear protective clothing (see Protective Clothing in Section 4.3).

Respirators

For most Type 3 operations, workers should wear a respirator with a NIOSH approved assigned protection factor of 50 (see Respirator Requirements in Table 1). Where the operation is abrasive blasting, the operator should wear a Type CE abrasive blast supplied air respirator operated in a pressure demand or positive pressure mode with a tight-fitting half-mask or tight-fitting full-facepiece.

It is recommended that compressed air used to supply supplied air respirators meet the breathing air purity requirements of CSA Standard Z180.1-00. Where an oil-lubricated compressor is used to supply breathing air, a continuous carbon monoxide monitor/alarm should be provided.

6.4.6 Clean-Up

Dust and waste should be cleaned up and removed by vacuuming with a HEPA filter equipped vacuum, wet sweeping and/or wet shovelling. Clean-up after each operation should be encouraged to prevent lead contamination and exposure to lead.

When abrasive blasting is finished, cleanup and removal of lead-containing dust and waste should take place.

APPENDIX 1: Medical Surveillance Of Lead-Exposed Workers

Where construction workers are exposed to airborne lead, measures and procedures to control their exposure should be implemented. This guide has outlined (in Section 4) the types of controls that should be in place for various work activities. But to ensure that these controls are effective they should be periodically evaluated. One way of doing this is by establishing a medical surveillance program. A medical surveillance program refers to the systematic collection, analysis, and evaluation of health data in the workplace to identify cases, patterns, or trends suggesting an adverse effect on workers' health. It is highly recommended that employers establish and maintain a medical surveillance program in their workplace.

The essential features of a lead medical surveillance program are outlined below.

Medical Surveillance Program

Purpose

The objective of a medical surveillance program is to protect the health of workers by:

- ensuring their fitness for exposure to lead
- evaluating their absorption of lead
- enabling remedial action to be taken when necessary
- providing health education.

Program

The medical surveillance program should include the following:

- pre-employment and pre-placement medical examinations
- periodic medical examinations
- clinical tests
- health education
- record keeping.

Medical Examinations

The medical examination should include the following:

History

The initial medical and occupational history should include enquiries about the worker's previous exposure to lead (both occupational and non-occupational), personal habits

(smoking and hygiene), and history of present or past gastrointestinal, hemopoietic, renal, reproductive, endocrine, or nervous disorders.

At subsequent examinations, the history should be updated to include:

- information on the frequency and duration of exposure to lead since the previous examination;
- the occurrence of signs and symptoms that may be an early indication of lead intoxication, e.g., abdominal pain, constipation, vomiting, asthenia, paraesthesia and psychological change.

Physical Examination

Medical surveillance should include a general physical examination. Particular attention should be directed to those systems that may be affected by lead. Personal hygiene should also be noted.

Biological Monitoring

Biological monitoring refers to the collection and assessment of bodily fluids or tissue, to evaluate occupational exposure to chemical hazards. The concentration of lead in a worker's blood is a good indicator of lead absorption by that individual. It does not indicate the total body burden of lead, but it is useful in the assessment of a worker's fitness for continued exposure to lead. As such, determining the blood lead levels in lead-exposed workers is highly recommended.

The concentration of lead in the blood can be used to determine:

- When a worker should be removed from lead exposure;
- When an enquiry regarding work practices and personal hygiene should be made;
- When further test(s) should be made; and,
- When a worker may be permitted to return to work.

The determination of whether a worker is fit, fit with limitations or unfit for exposure to lead should only be made by a physician. In addition, a physician should determine the required frequency for biological monitoring on an individual basis.

If symptoms or signs of lead intoxication are present the worker should be removed from lead exposure regardless of blood lead level.

In addition, it is recommended that a pre-placement blood-lead test be taken to establish a baseline for each worker that is exposed to lead.

APPENDIX 2: Respirator Requirements & Other Measures and Procedures for Type 1, 2, and 3 Lead-Containing Operations

OPERATIONS	REQUIRED RESPIRATOR	OTHER MEASURES & PROCEDURES
TYPE 1		
• Application of lead-containing coatings with a brush or roller. • Removal of lead-containing coatings with a chemical gel or paste and fibrous laminated cloth wrap. • Removal of lead-containing coatings or materials using a power tool that has an effective dust collection system equipped with a HEPA filter. • Installation or removal of lead-containing sheet metal. • Installation or removal of lead-containing packing, babbit or similar material • Removal of lead-containing coatings or materials using non-powered hand-held tools, other than manual scraping or sanding. • Soldering.	Respirators should not be necessary if general procedures listed in Section 6.1 of the Guideline are followed and if the levels of lead in air are less than 0.05 mg/m^3. However, if the worker wishes to use a respirator, a half-mask particulate respirator with N-, R- or P-series filter, and 95, 99 or 100% efficiency should be provided.	• Washing facilities consisting of wash basin, water, soap and towels should be provided and workers should use these washing facilities before eating, drinking, smoking or leaving the project; • Workers should not eat, drink, chew gum or smoke in the work area; • Dust and waste should be cleaned up at regular intervals and placed in a container that is: - dust tight - identified as containing lead waste - cleaned with a damp cloth or a vacuum equipped with a HEPA filter immediately before being removed from the work area - removed from the workplace frequently and at regular intervals; • Drop sheets should be used below all lead operations which produce or may produce dust, chips, or debris containing lead; • Cleanup after each operation is encouraged to prevent lead contamination and exposure to lead; • Work area should be inspected at least daily to ensure that the work area is clean; • Compressed air or dry sweeping should not be used to clean up any lead-containing dust or waste from a work area or from clothing.

OPERATIONS	REQUIRED RESPIRATOR	OTHER MEASURES & PROCEDURES
TYPE 2		
TYPE 2a		
• Welding or high temperature cutting of lead-containing coatings or materials outdoors. This operation is considered a Type 2a operation only if it is short-term, not repeated, and if the material has been stripped prior to welding or high temperature cutting. • Removal of lead-containing coatings or materials by scraping or sanding using non-powered hand tools • Manual demolition of lead-painted plaster walls or building components by striking a wall with a sledge hammer or similar tool	Half-mask particulate respirator with N-, R-, or P-series filter and 95, 99 or 100 percent efficiency.	**(In addition to Type 1 measures and procedures.)** • Signs should be posted in sufficient numbers to warn of the lead hazard. There should be a sign, at least, at each entrance to the work area. The signs should display the following information in large, clearly visible letters: - There is a lead dust, fume or mist hazard. - Access to the work area is restricted to authorized persons. - Respirators must be worn in the work area. • Suitable protective clothing and equipment should be worn by every worker who enters the work area (refer to Section 4.3 of the guideline).
TYPE 2b		
• Spray application of lead-containing coatings.	Powered air purifying respirator equipped with a hood or helmet, and a high efficiency filter. OR Supplied air respirator equipped with a hood or helmet and operated in a continuous flow mode.	

OPERATIONS	REQUIRED RESPIRATOR	OTHER MEASURES & PROCEDURES
TYPE 3		
TYPE 3a		**(In addition to Type 1 and Type 2 measures and procedures.)** • For Type 3a operations conducted indoors or outdoors, enclosures should be provided in the form of barriers, partial enclosures, or full enclosures. • For Type 3b operations conducted indoors, full enclosures should be provided. • With the exception of dry abrasive blasting conducted outdoors, enclosures provided for all other Type 3b operations conducted outdoors should be in the form of barriers, partial enclosures, or full enclosures. For dry abrasive blasting outdoors, full enclosures should be provided. • Where there is an enclosure, general mechanical ventilation should be provided. • A decontamination facility (refer to 6.4.3 of the guideline) should be made available for workers carrying out the following operations: - abrasive blasting of lead-containing coatings or materials - the removal of lead-containing coatings or materials using power tools without an effective dust collection system equipped with a HEPA filter - removal of lead-containing dust using an air mist extraction system - demolition or cleanup of a facility where lead-containing products were manufactured. • When abrasive blasting is finished, dust and waste should be cleaned up and removed by vacuuming with a HEPA filter equipped vacuum, wet sweeping and/or wet shovelling. • Where a dust generating operation is carried out, local exhaust ventilation should be provided to remove dust at the source. Wet methods should also be incorporated in the operation to reduce dust generation.
• Welding or high temperature cutting of lead-containing coatings or materials indoors or in a confined space. • Burning of a surface containing lead. • Dry removal of lead-containing mortar using an electric or pneumatic cutting device. • Removal of lead-containing coatings or materials using power tools without an effective dust collection system equipped with a HEPA filter. • Removal or repair of a ventilation system used for controlling lead exposure. • Demolition or cleanup of a facility where lead-containing products were manufactured. • An operation that may expose a worker to lead dust, fume or mist that is not a Type 1, Type 2, or Type 3b operation.	Full-facepiece air-purifying respirator equipped with N-, R-, or P-series filter and 100% efficiency. OR Tight-fitting PAPR with a high efficiency particulate filter. OR Half-mask or full-facepiece supplied air respirator operated in a continuous flow mode. OR Half-mask supplied air respirator operated in pressure-demand or other positive-pressure mode.	
TYPE 3b		
• Abrasive blasting of lead-containing coatings or materials.	Type CE abrasive-blast supplied air respirator operated in a positive-pressure mode with a tight-fitting half-mask facepiece. Type CE abrasive-blast supplied air respirator operated in a pressure-demand or positive pressure mode with a tight-fitting full-facepiece	
• Removal of lead-containing dust using an air mist extraction system	Supplied air respirator equipped with a tight-fitting half-mask or full-facepiece and operated in pressure demand or positive pressure mode.	

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